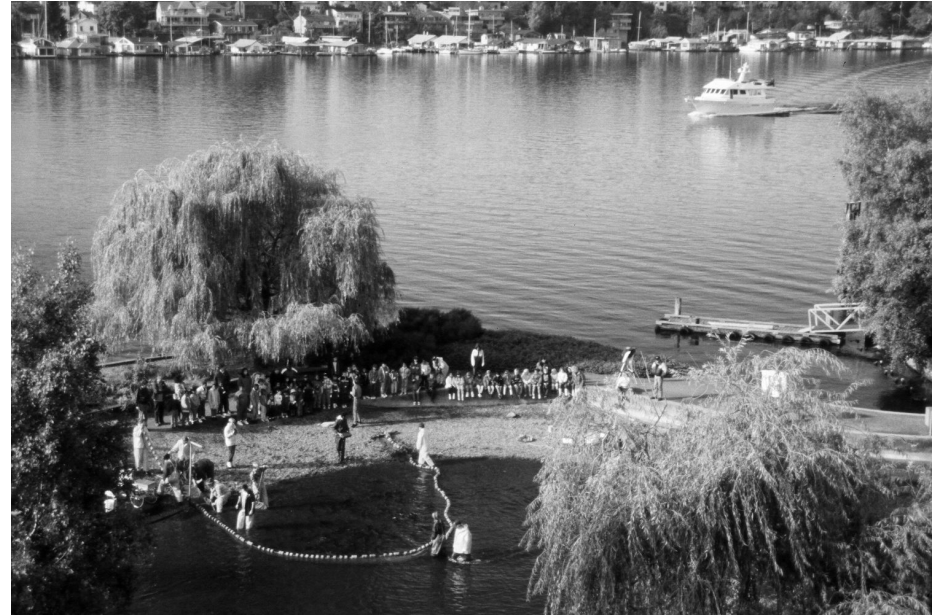


What have we learned about salmon at the University of Washington hatchery?



Thomas Quinn
**School of Aquatic
and Fishery Sciences**
**University of
Washington**





Artist's rendering of the Fisheries Center, completed in 1950.



Pond became operational in 1961

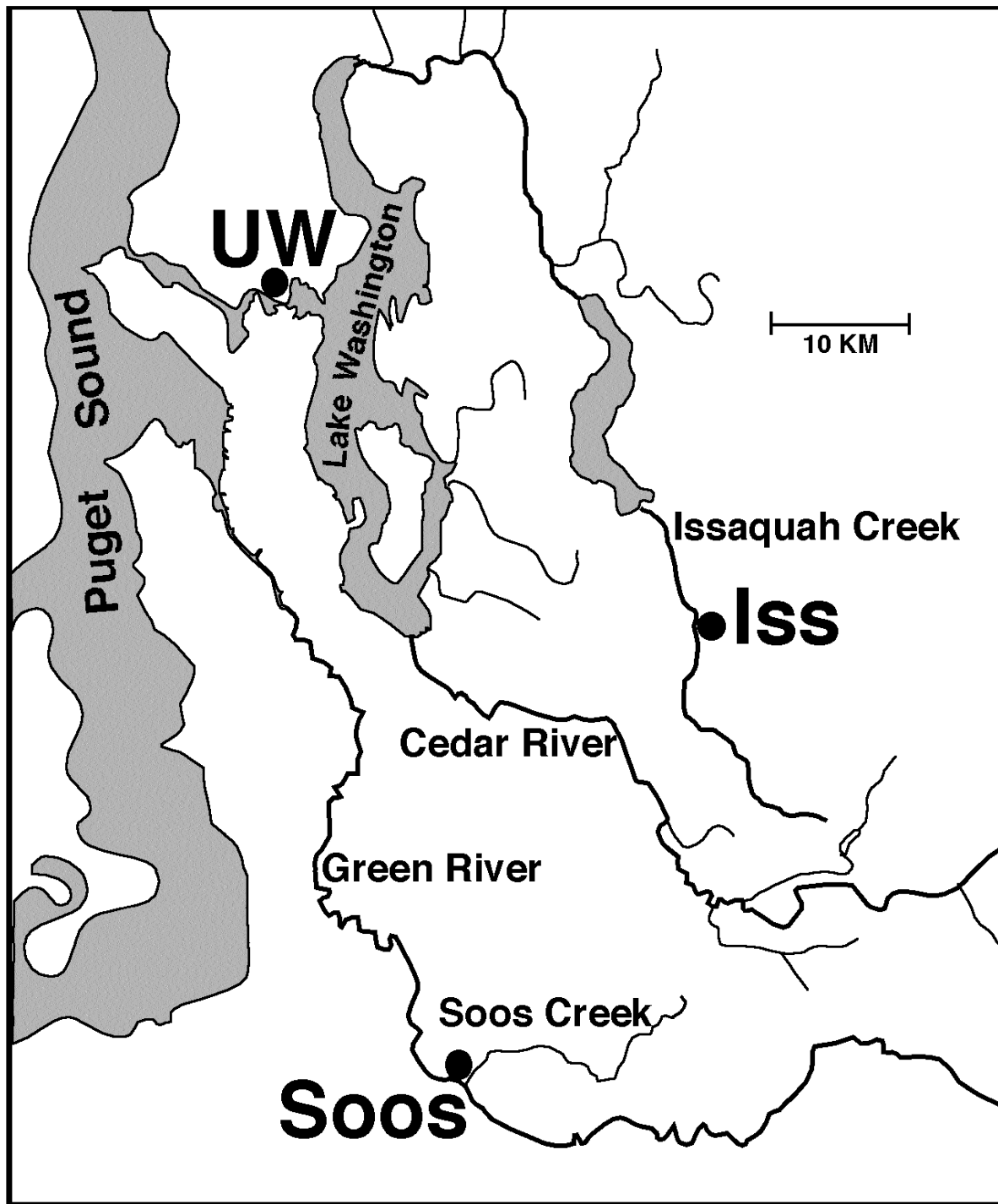
Fish culture at the UW hatchery

Coho and chinook salmon are *largely* from Soos Creek.

Chinook are “ocean-type”, typical of local populations.

Efforts to rear yearling coho were unsuccessful because ship canal water is too warm in the summer. So, coho development is accelerated, producing age-0 smolts.





**University of
Washington
hatchery:**

**Chinook salmon
since 1954 and
coho since 1969**

**Soos Creek and
Issaquah Creek
hatcheries:
chinook data
since 1960 and
coho since 1942**

**Purpose: enter, archive,
and analyze long-term
data for trends in:**

- 1. Spawning date**
- 2. Female size, age, and egg production**
- 3. Male size, age at maturity**
- 4. Marine survival**



Part I: Trends in spawning date

Salmon tend to spawn later where water is warm because it may be intolerable to adults, and it accelerates embryo development.

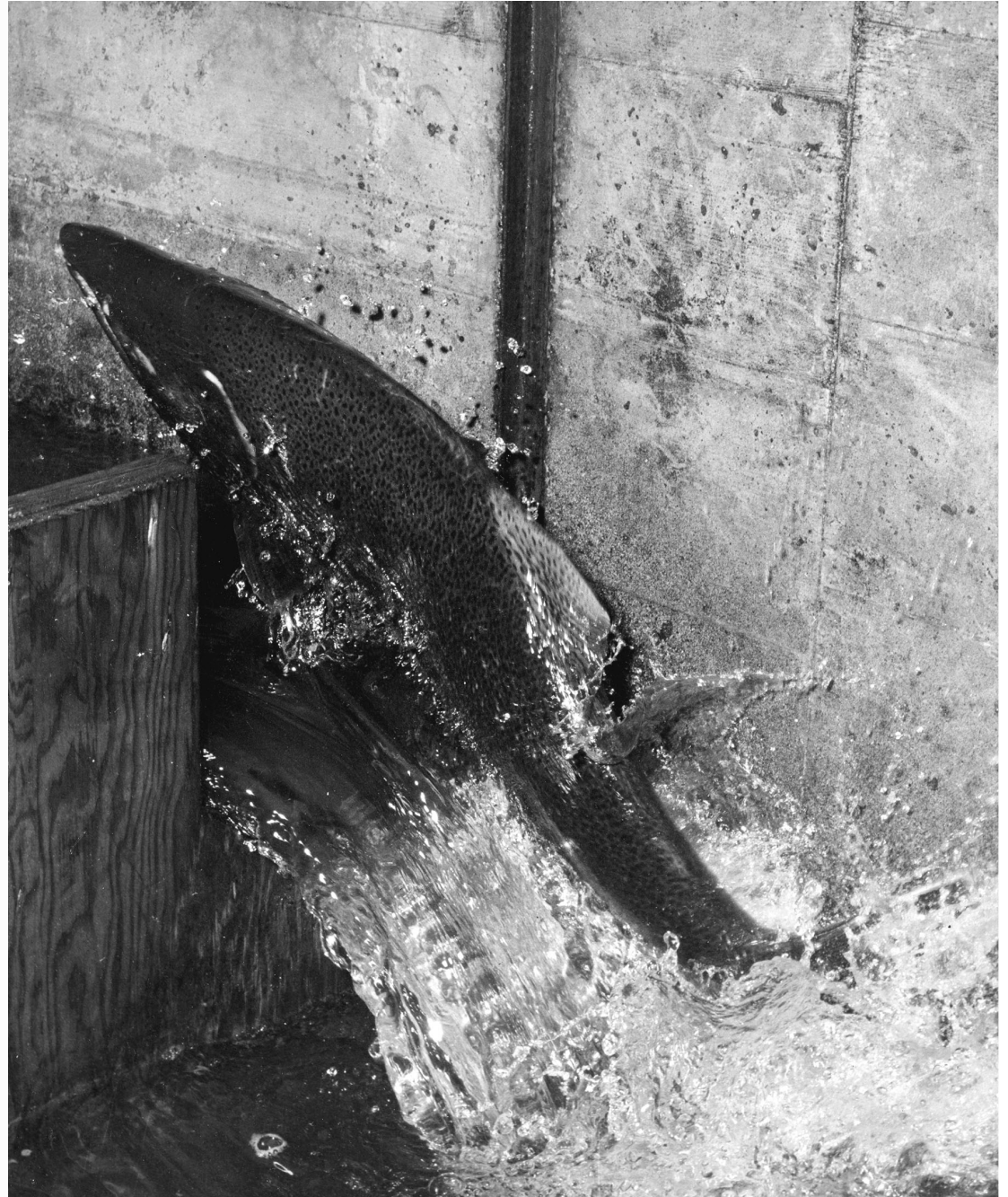
Hatcheries tend to spawn the earliest maturing salmon and so spawning becomes earlier over a period of years.

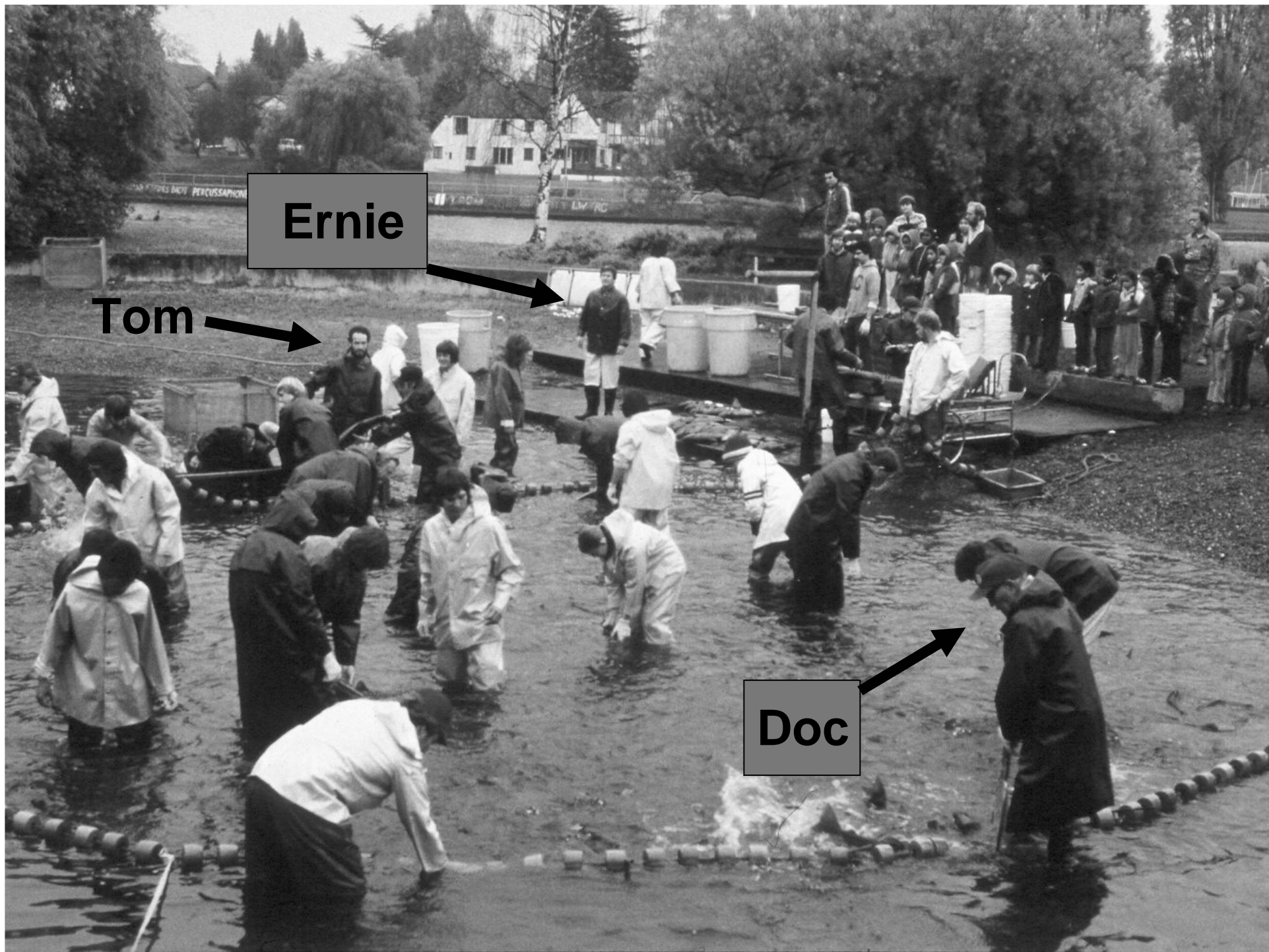
What happens when these processes oppose each other?

Goals: Test the hypotheses that:

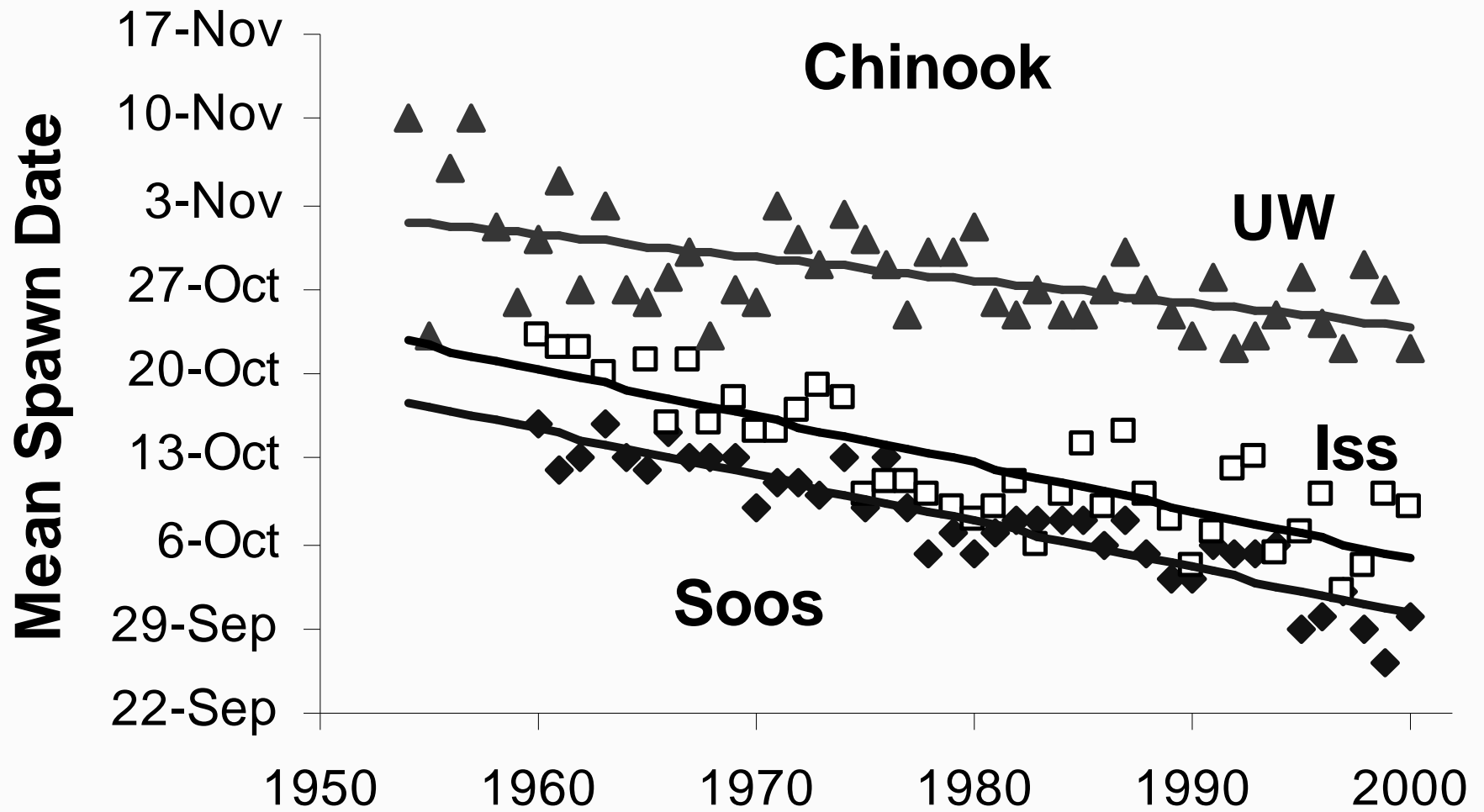
The spawning period has become earlier [stayed the same] at UW and other local hatcheries.

Changes in spawning date have been in spite of [because of] water temperature changes.

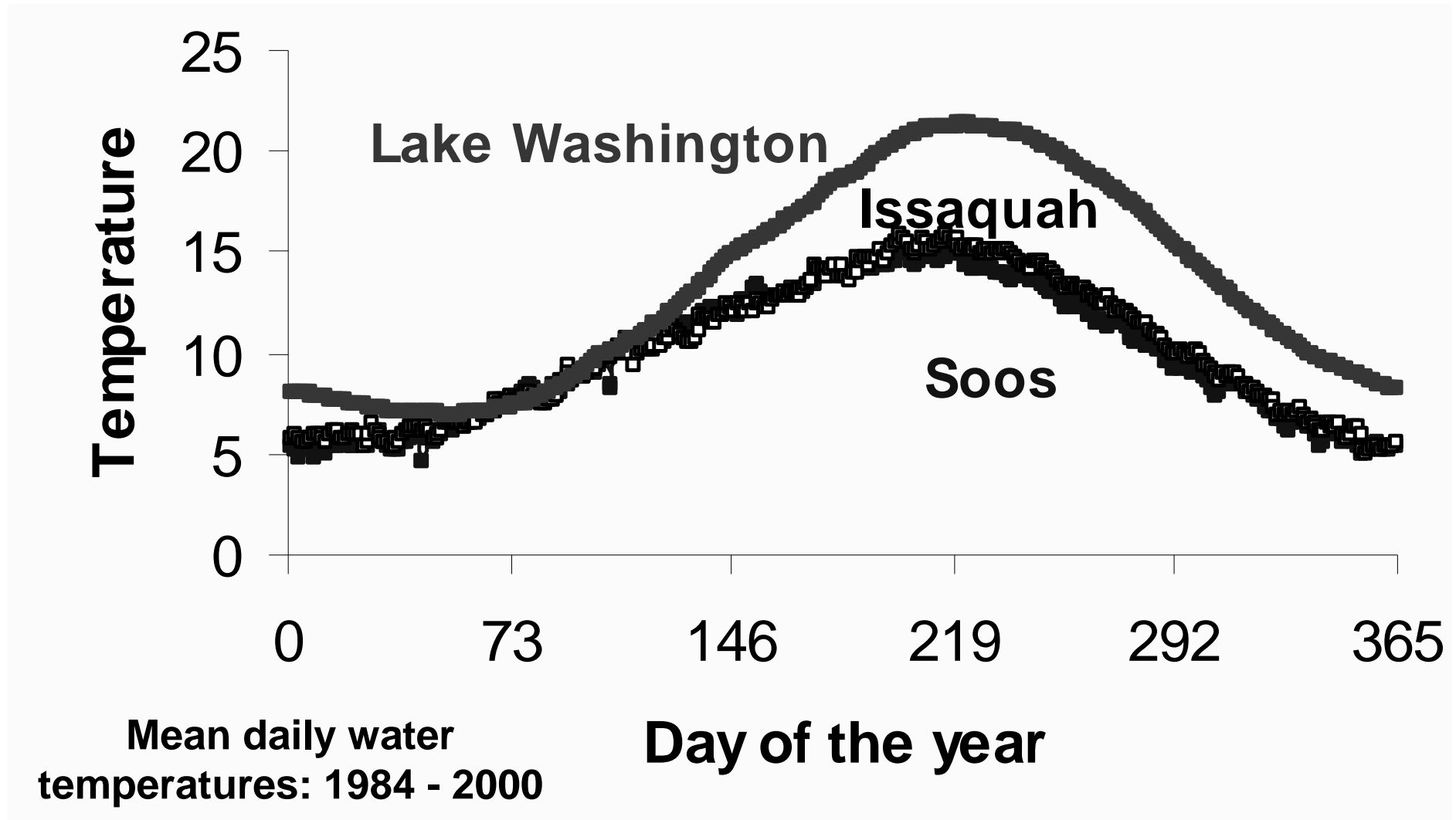




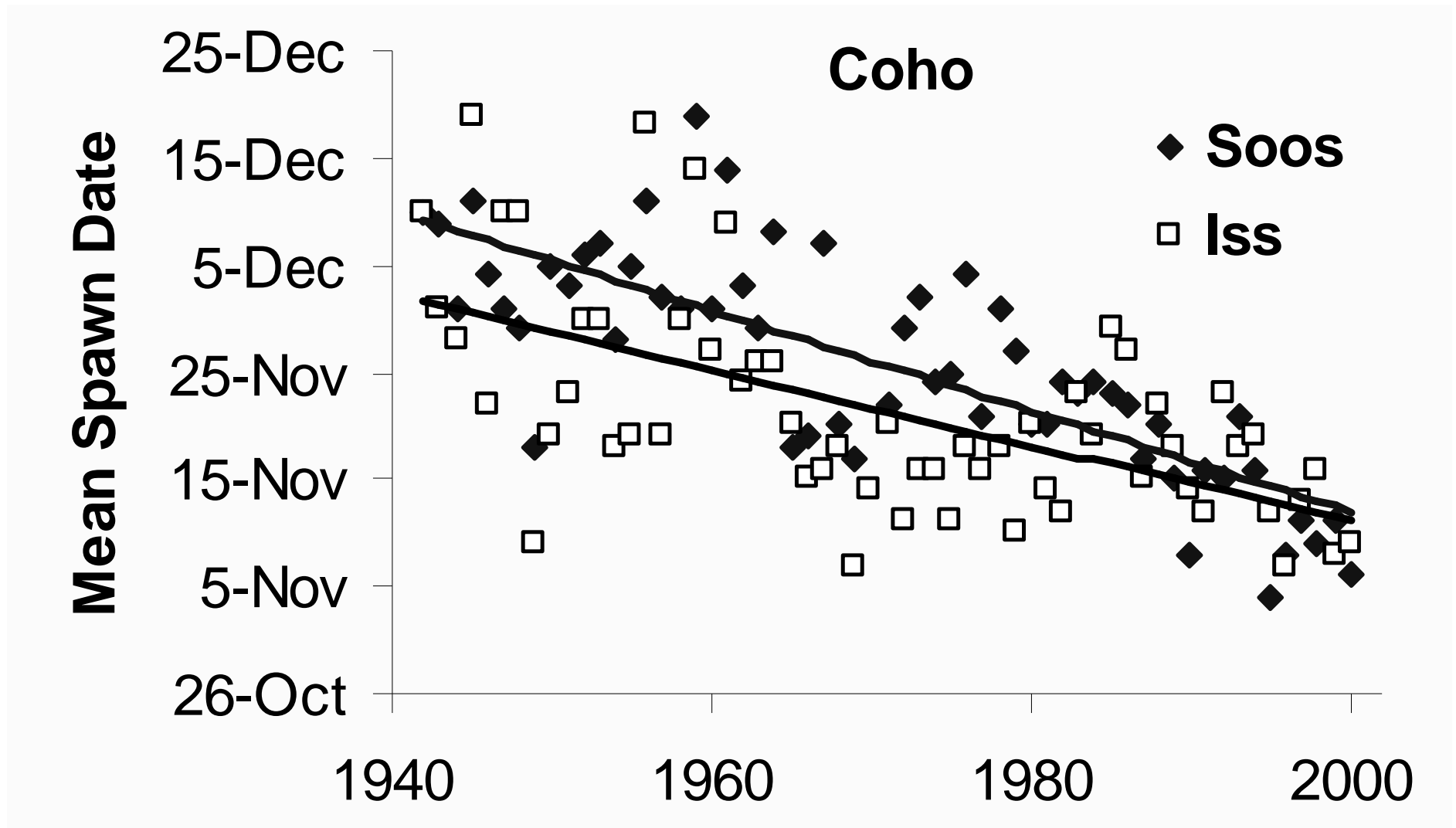
Mean spawning dates of female salmon



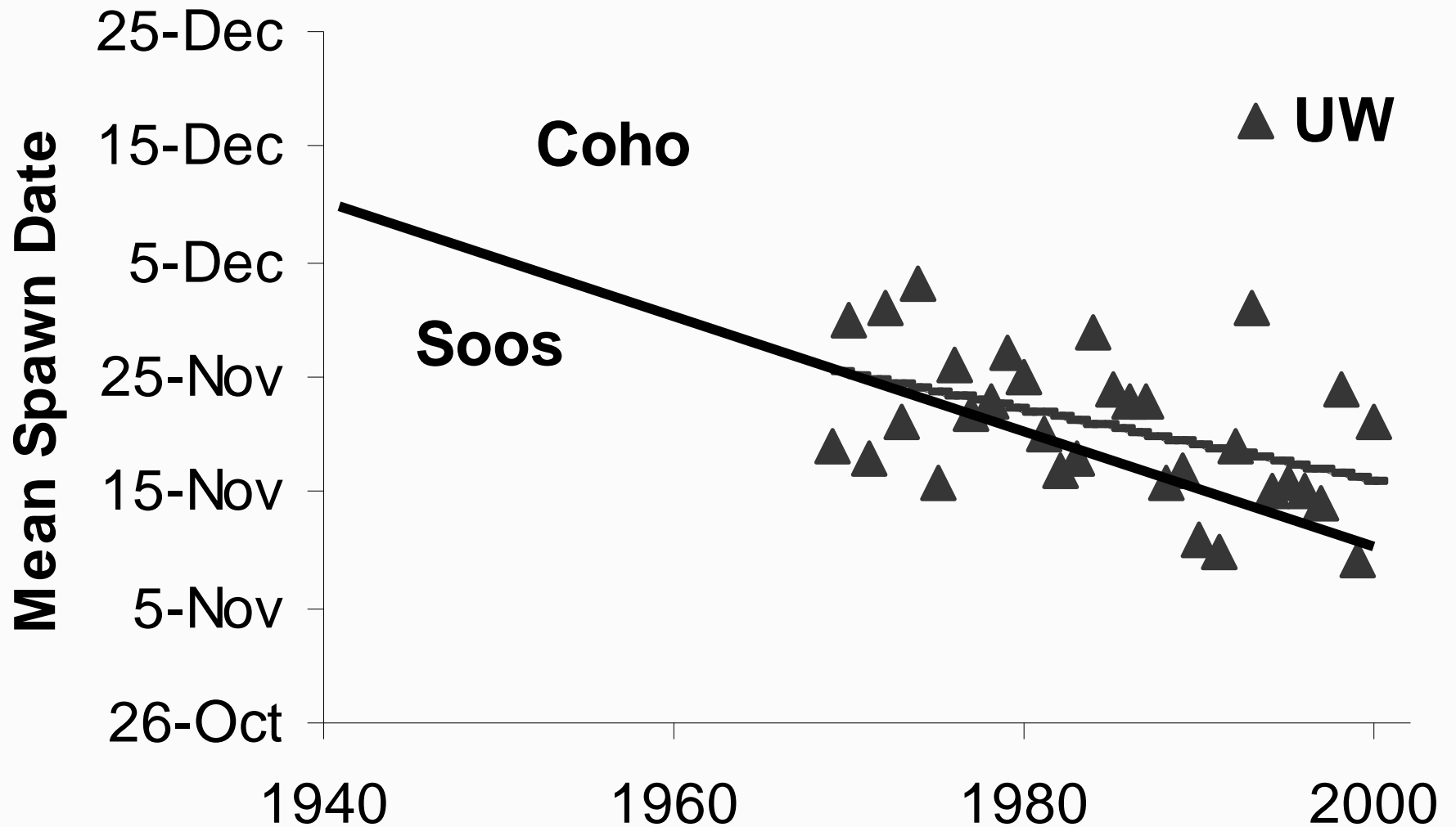
The sequence of spawning (Soos, then Issaquah, then UW) is consistent with thermal regimes



Mean spawning dates of hatchery salmon

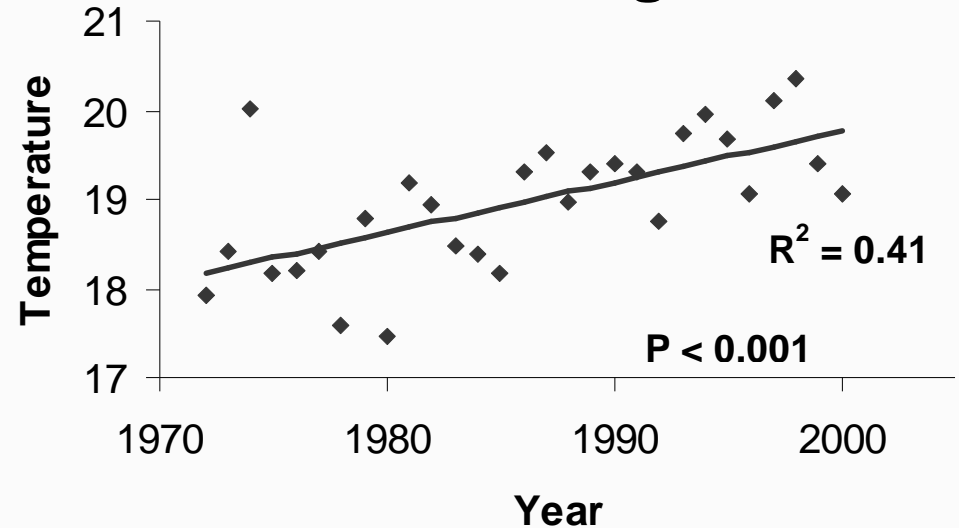


Mean spawning dates of hatchery salmon

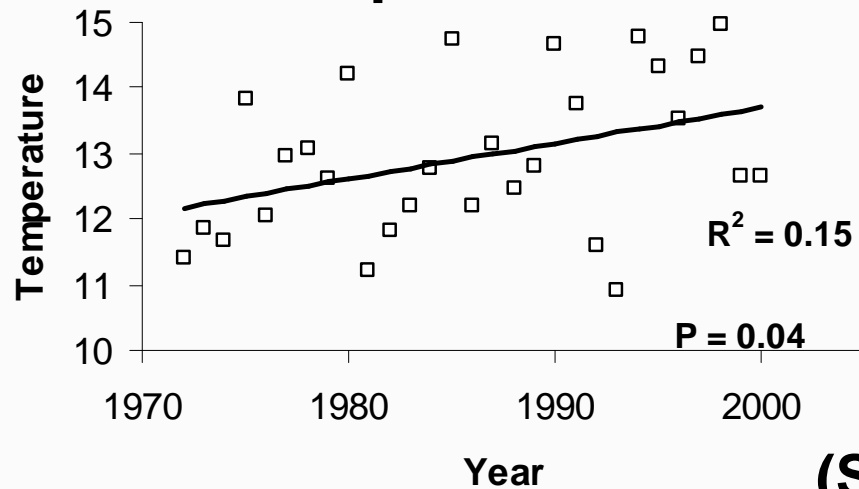


Water temperatures have been getting warmer, which should have resulted in later, not earlier, spawning. This suggests the role of artificial selection.

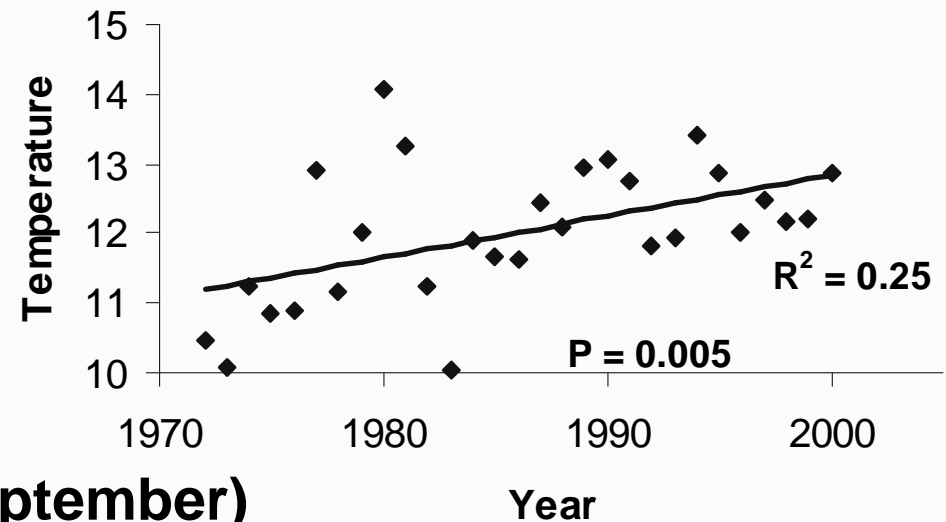
Lake Washington



Issaquah Creek

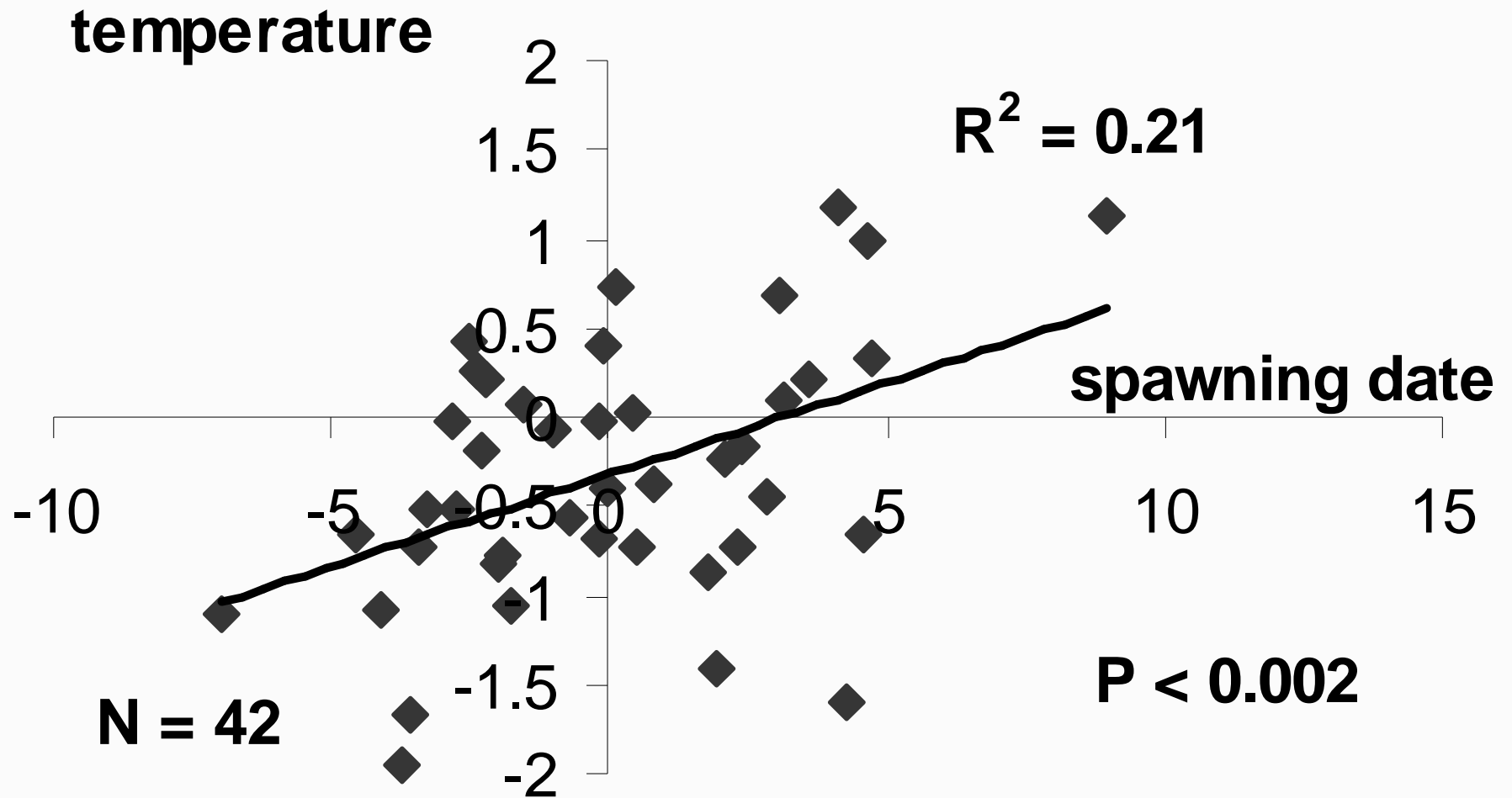


Soos Creek

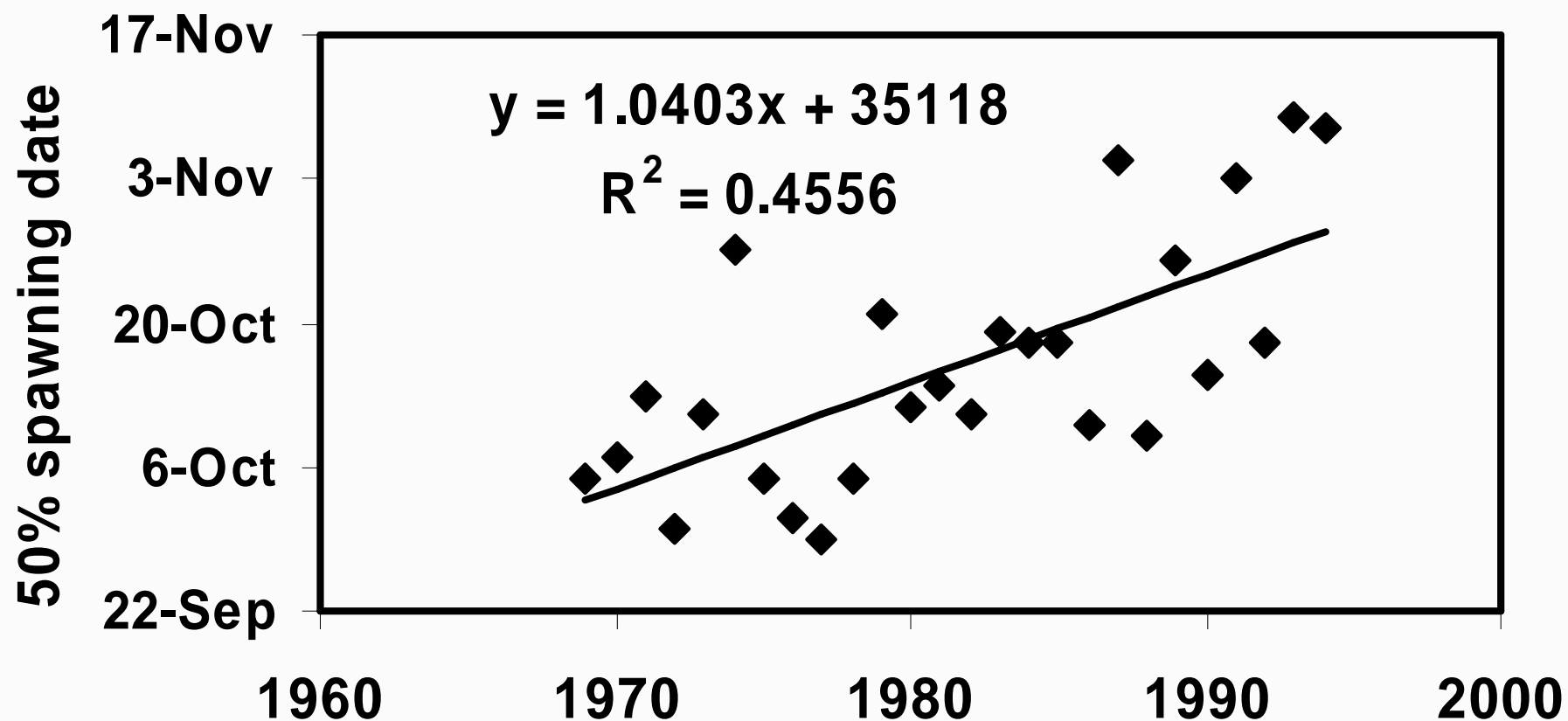


(September)

However, after removal of the time trend, UW chinook spawning date tended to be later when water temperatures (in September) were warm



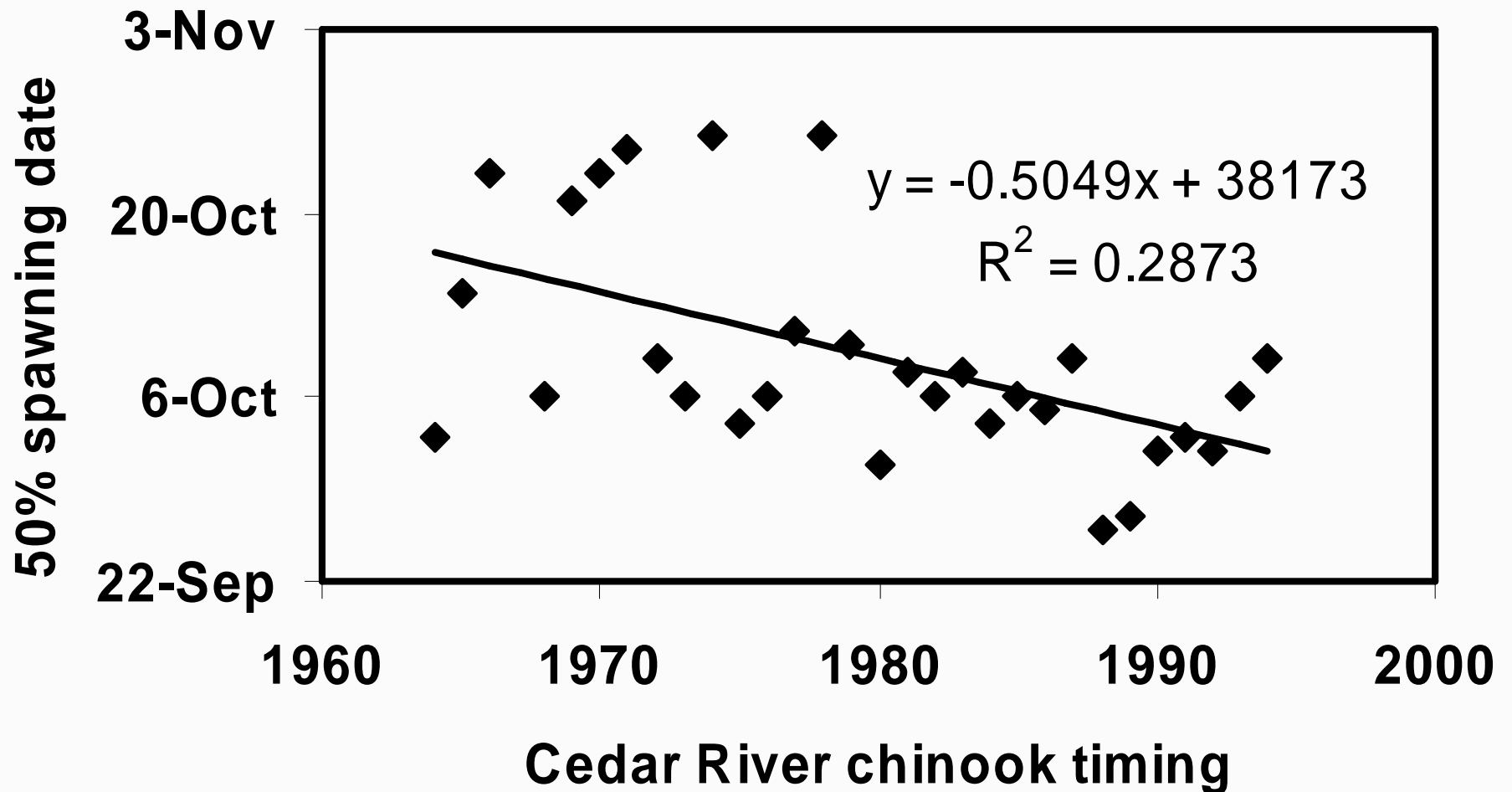
What about wild salmon?



Cedar River sockeye timing

Data: WDF/Cascade
Environmental Services (1995)

What about wild salmon?



Data: WDF/Cascade
Environmental Services (1995)

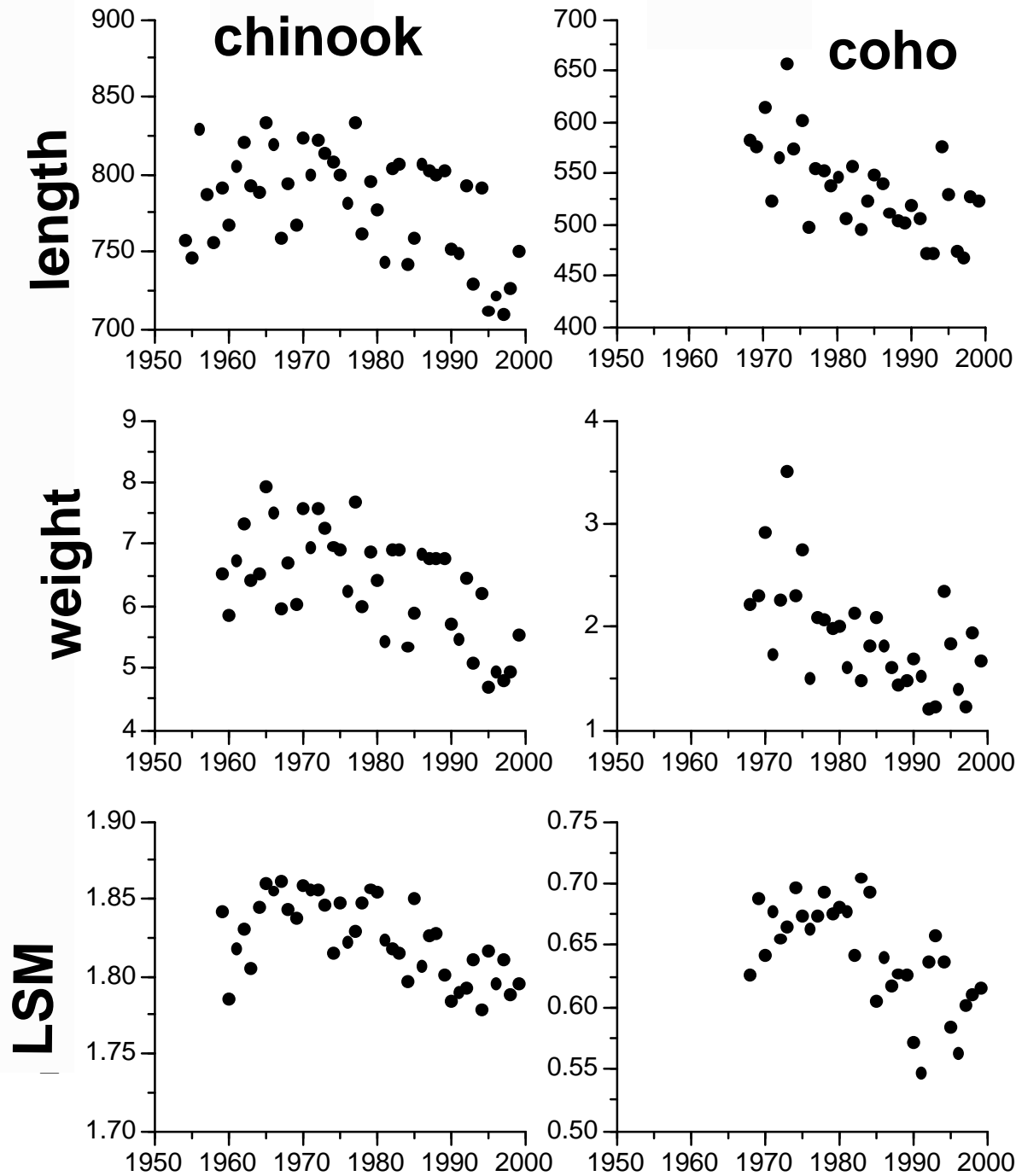
Conclusions:

- 1. Chinook spawn before coho salmon**
- 2. Both species spawn earlier than in the past**
- 3. This earlier spawning has probably resulted from artificial selection, and has taken place despite warmer temperatures at each site**
- 4. Warm water also delayed UW chinook salmon**
- 5. In the Cedar River, the trend (through 1994) was later for sockeye but earlier for chinook**

Part II: Female size, growth and egg production

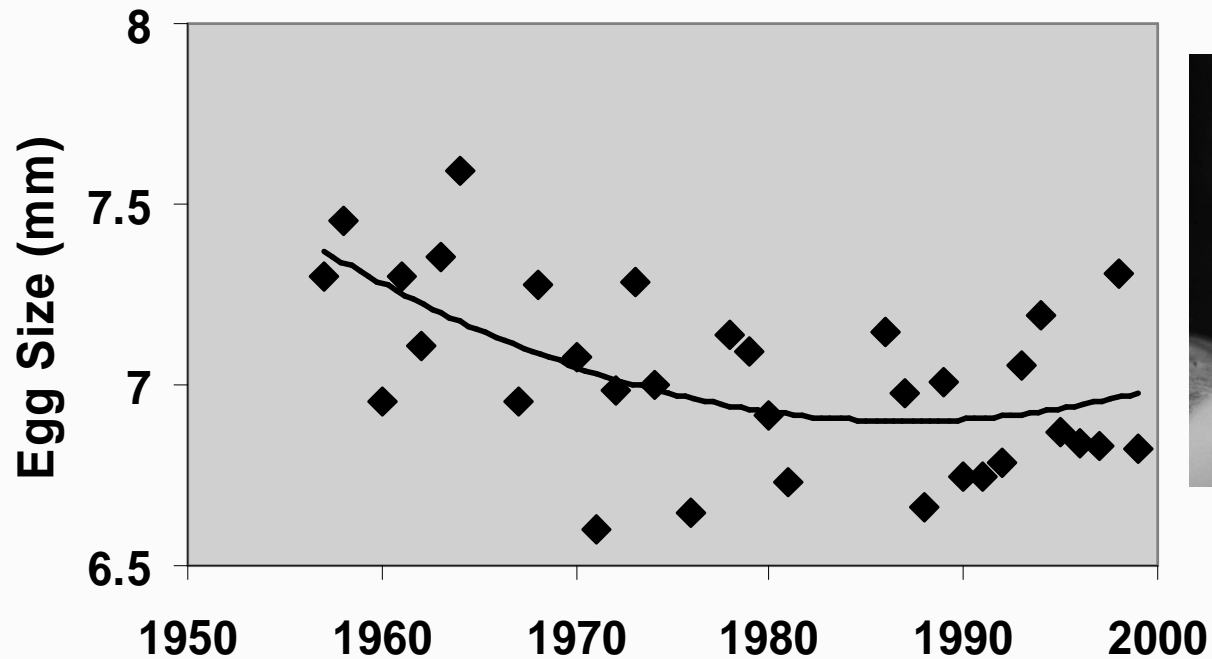
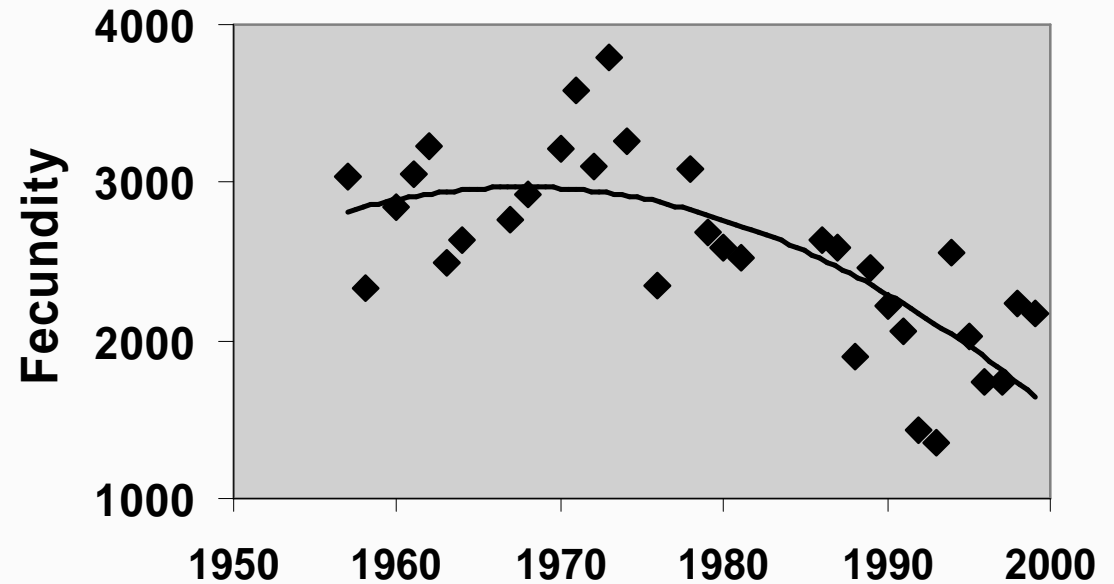
Body size has declined in many salmon populations. Do the UW fish mirror this trend? How do females allocate reproductive effort when size declines?



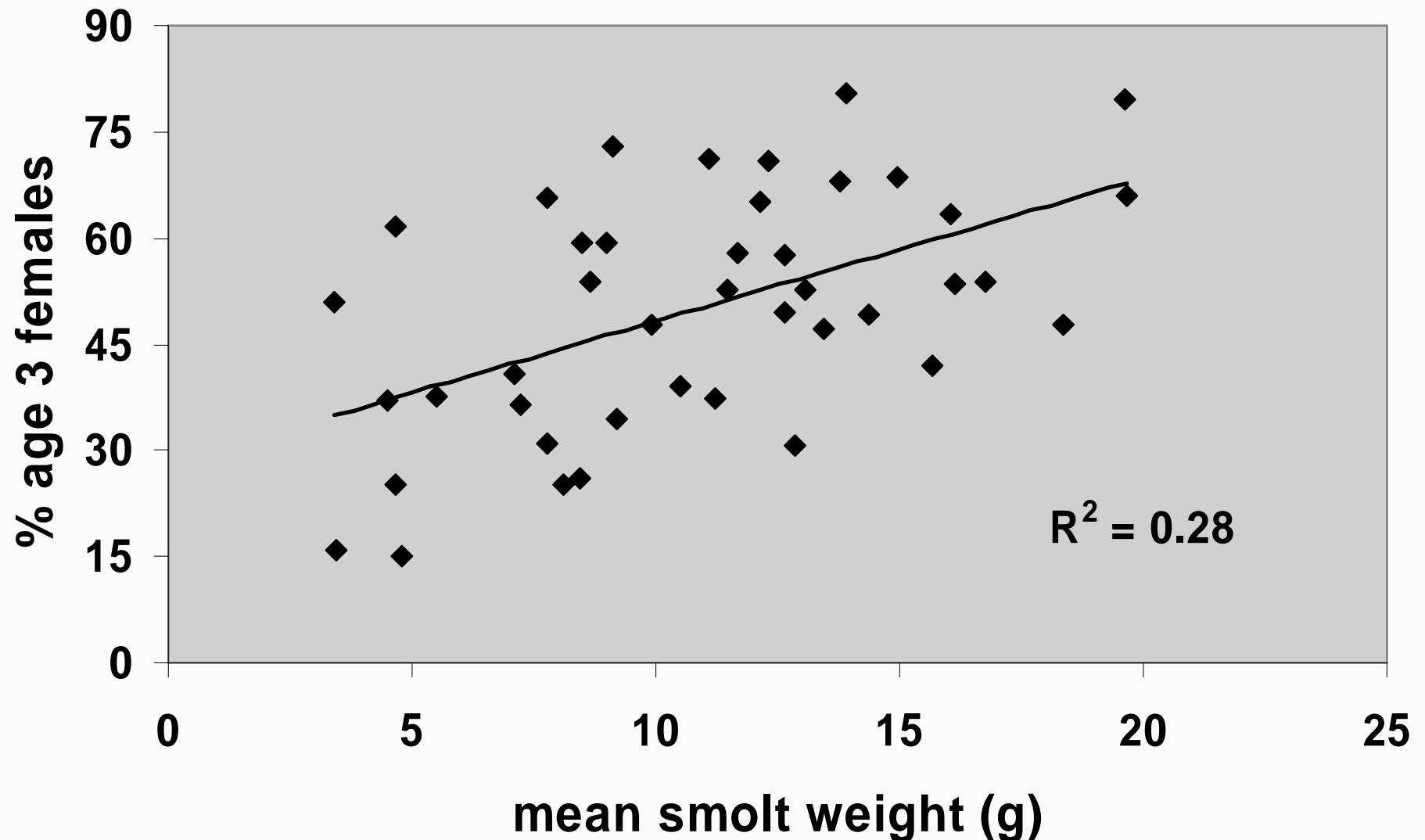


**Female UW
chinook and
coho have been
getting shorter,
and lighter, and
thinner, since
about 1970.**

In coho, declining growth at sea has been associated with decreased fecundity but not egg size



The tendency to release larger smolts resulted in younger, hence smaller, adult female chinook (this age shift does not occur in coho)



Conclusions regarding females

Female coho and chinook are smaller at maturity. In coho, the decline reflected slower growth at sea, and was correlated with the PDO. Chinook size at age did not change but the larger smolts caused females to return after 3 rather than 4 years at sea.

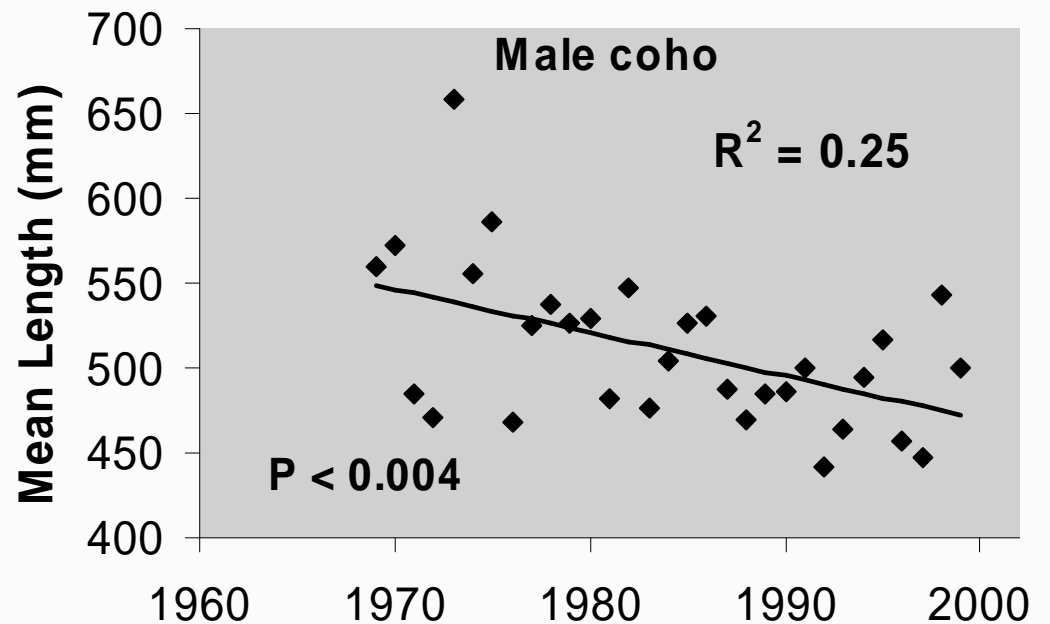
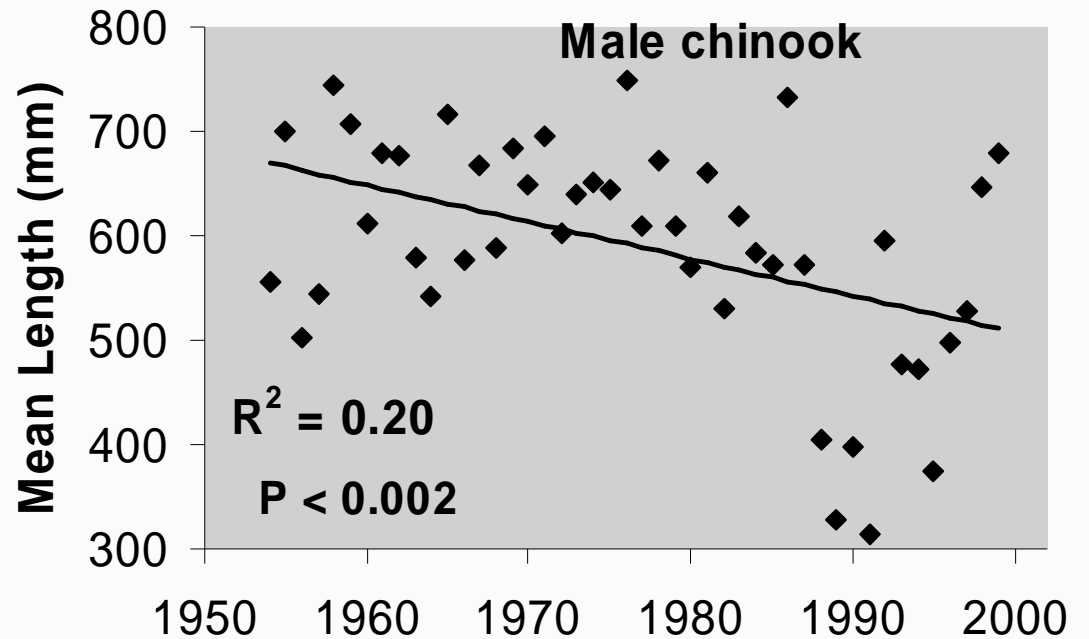
Part III: Male size and age at maturity

What are the trends in size of male salmon?

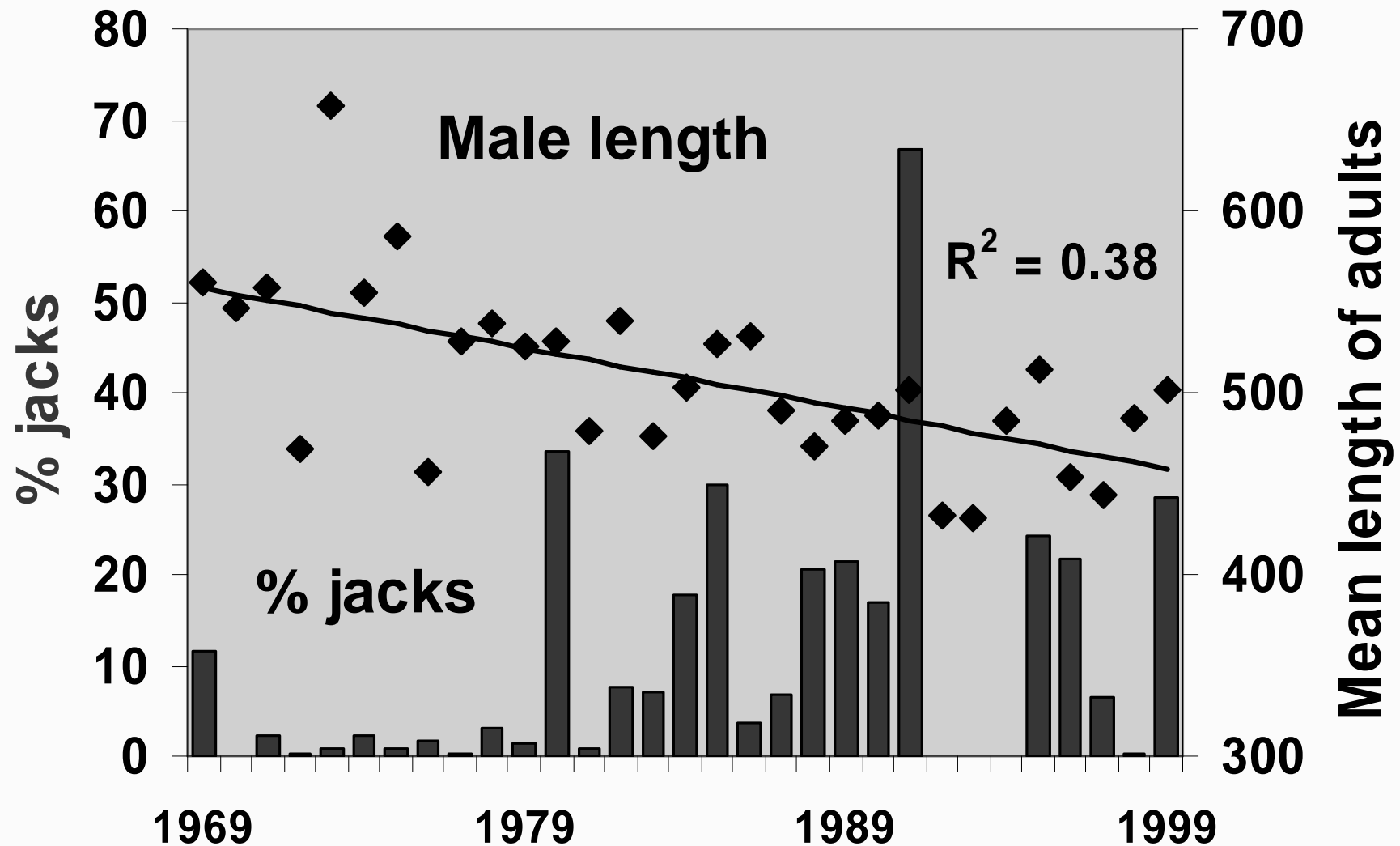
How do growth rates in freshwater and at sea influence male age at maturity?



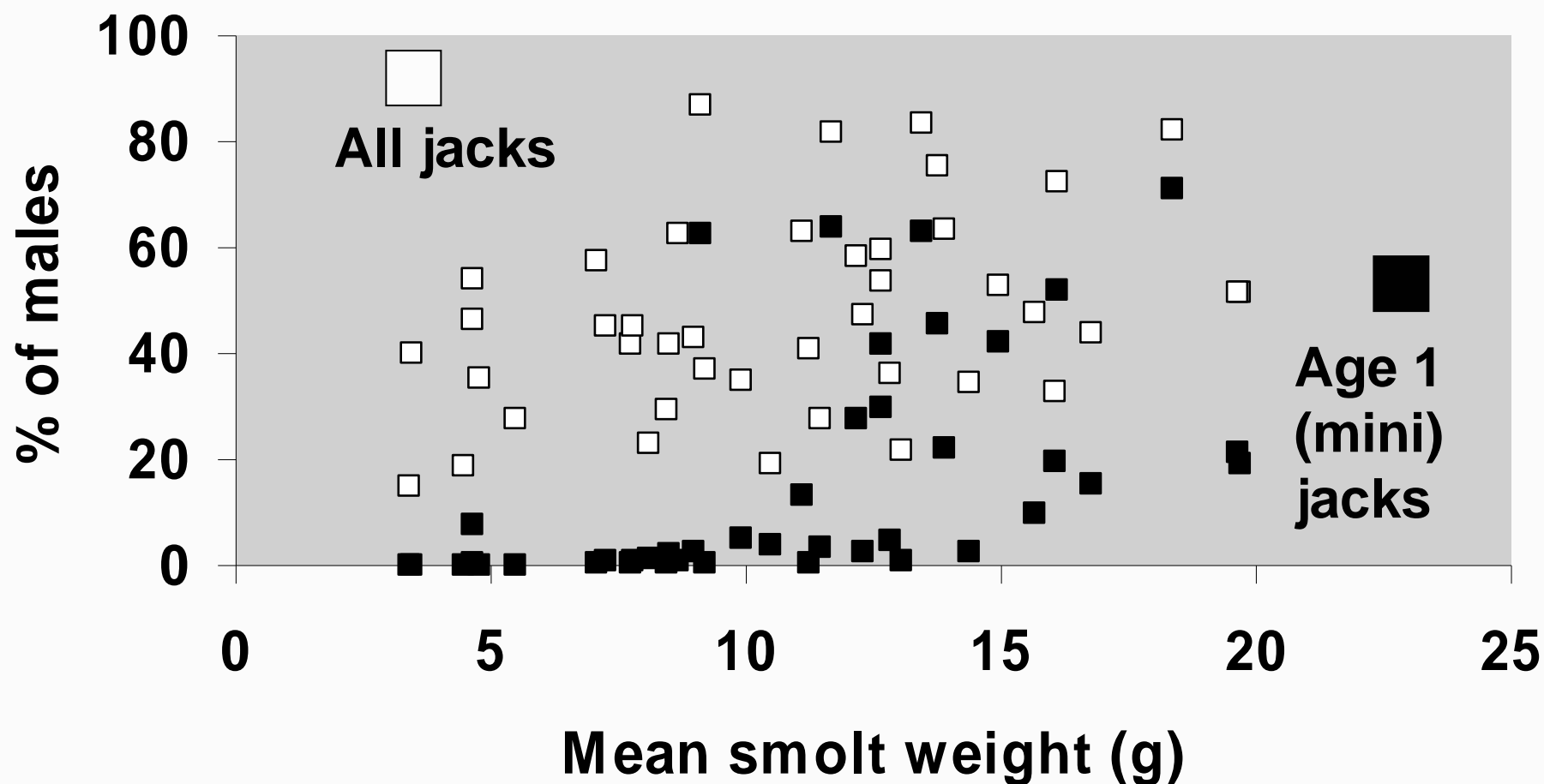
Male chinook and coho, including all ages, have shown marked declines in average length (and weight) at the UW hatchery



In coho, the decline in male size resulted from slower growth at sea, and more jacks



In chinook, smolt size affects the proportion of jacks, and especially the age 1 (“mini”) jacks



Conclusions: male growth and maturation

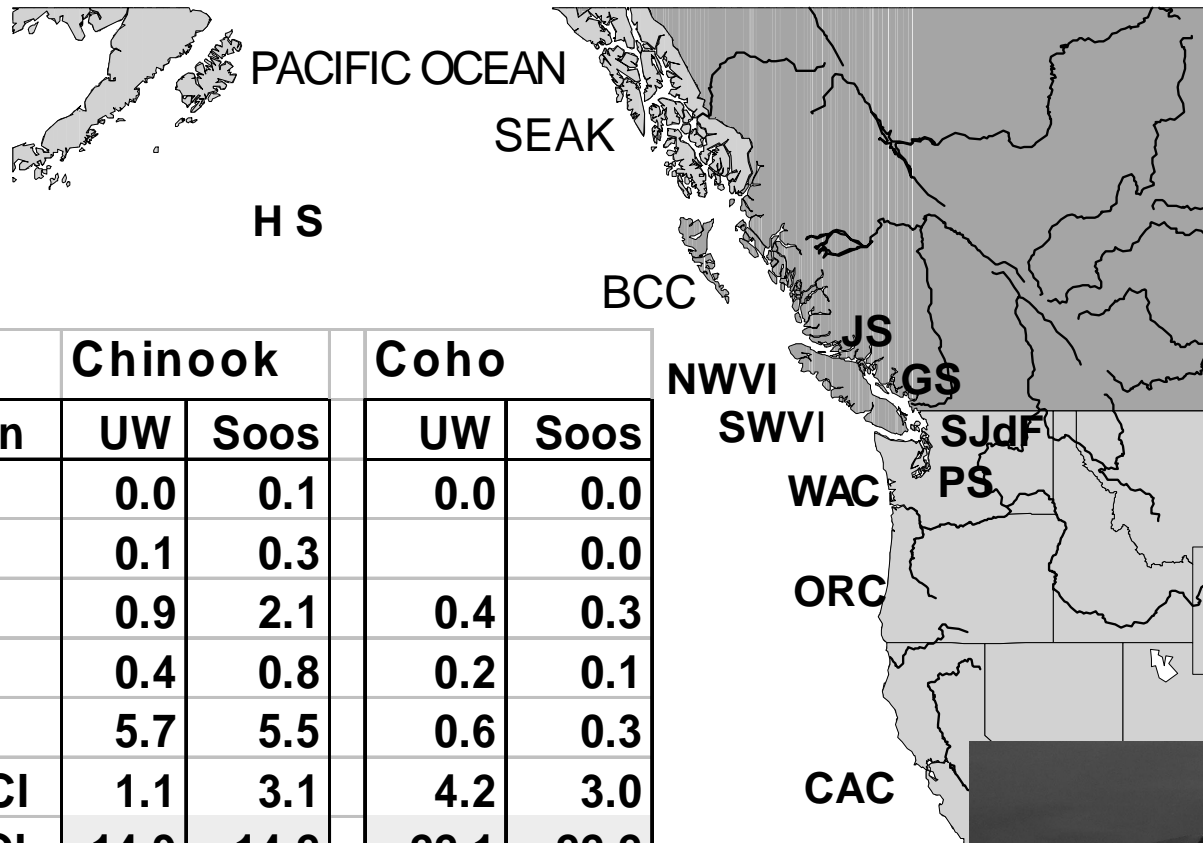
- 1. In coho, smolt size had a weak, positive effect on the proportion of jacks, and marine growth had a negative effect on proportion of jacks.**
- 2. In chinook, smolt size affected the proportion of jacks and especially mini-jacks; marine growth had no effect.**
- 3. The increase in proportion of jacks took place despite their exclusion from spawning.**
- 4. Size at age patterns largely mirrored those of females: smaller in adult coho but not chinook.**

Part IV: Factors affecting survival of chinook and coho salmon

Approaches:

- 1. Describe spatial distributions of catches**
- 2. Estimate survival from cwt or harvest rates**
- 3. Was survival related to smolt size in either species?**
- 4. Was survival of the two species correlated among years?**
- 5. Was survival of either species correlated with survival at Soos Creek hatchery?**
- 6. Was survival of these salmon populations consistently related to environmental variables?**

Catch distributions of UW and Soos Creek salmon



Distributions were nearly identical between populations for each species.

	Chinook		Coho	
Region	UW	Soos	UW	Soos
HS	0.0	0.1	0.0	0.0
SEAK	0.1	0.3		0.0
BCC	0.9	2.1	0.4	0.3
JS	0.4	0.8	0.2	0.1
GS	5.7	5.5	0.6	0.3
NWVCI	1.1	3.1	4.2	3.0
SWVCI	14.9	14.2	22.1	22.2
SJdF	14.1	13.0	16.0	10.2
PS	57.9	57.9	39.5	53.2
WAC	4.7	2.8	14.8	9.4
ORC	0.1	0.2	2.1	1.2
CAC			0.0	0.0

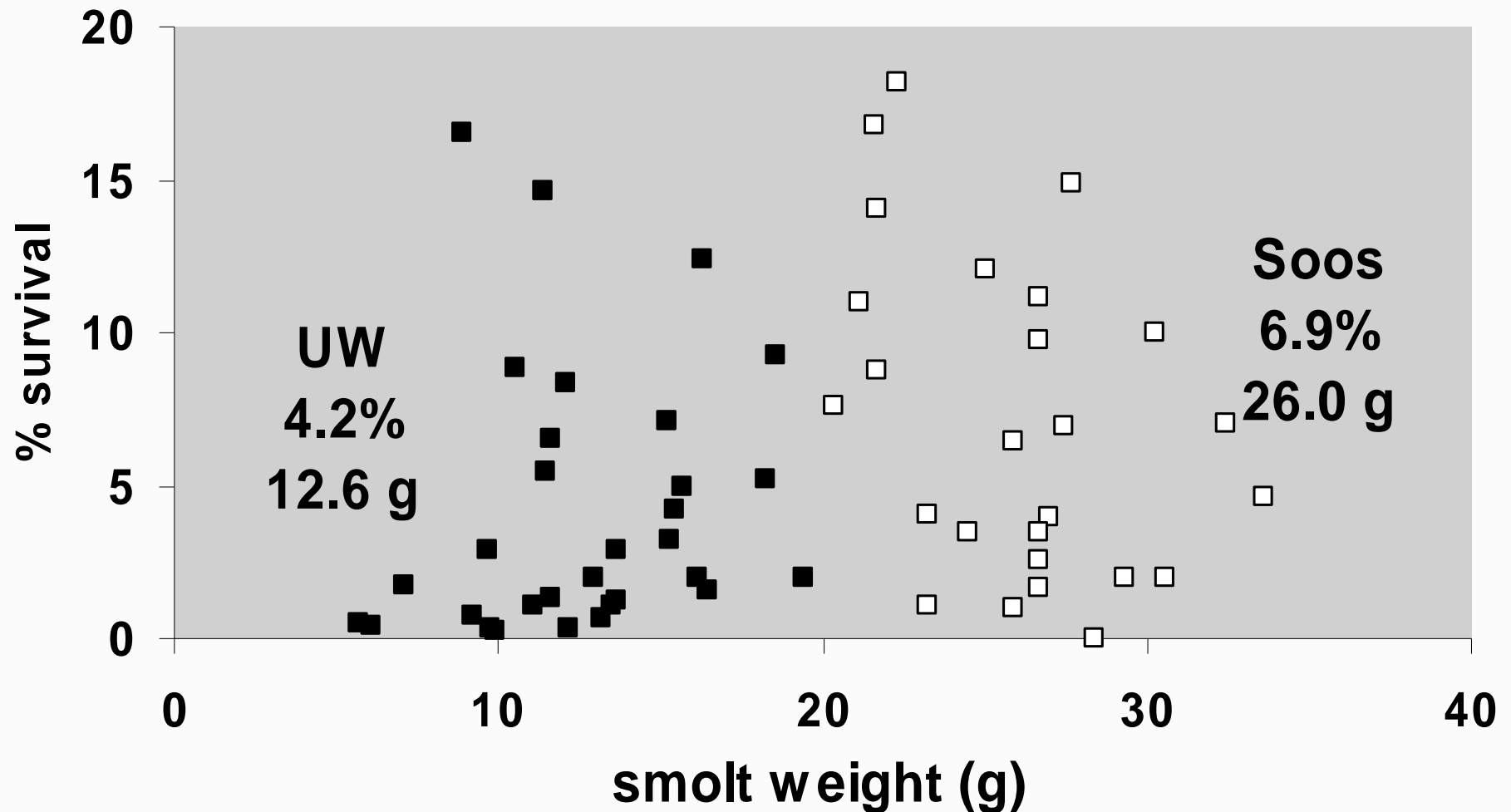
% of expanded recoveries



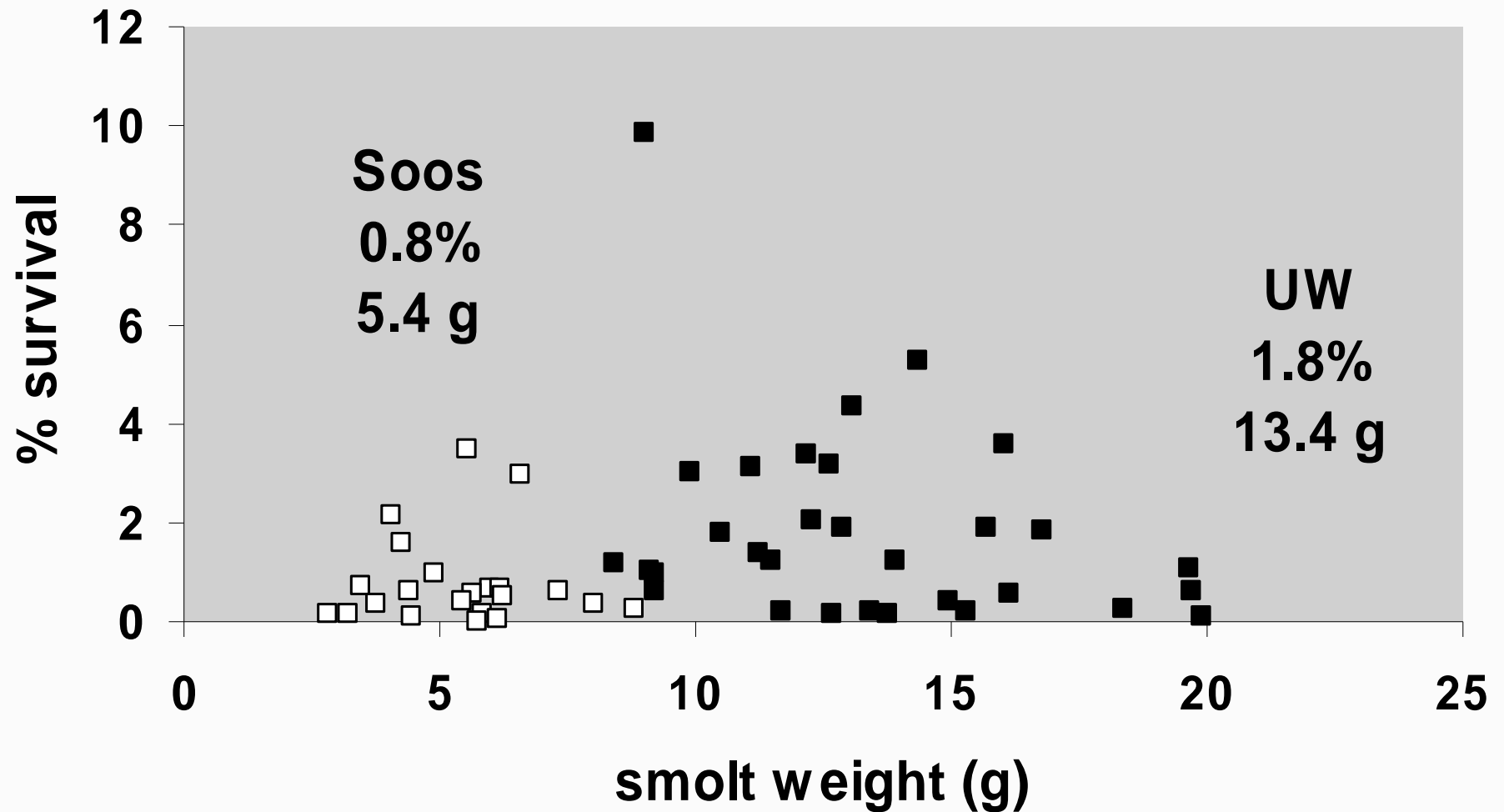
H. Berge

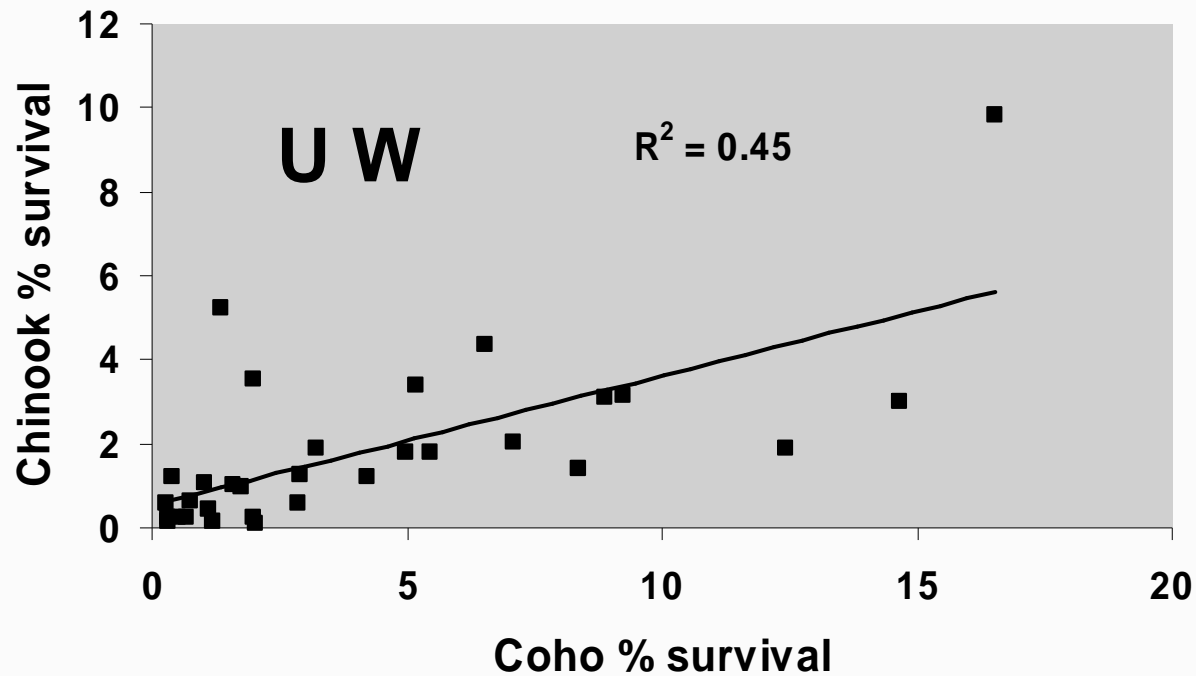
10.29.2001

Soos Creek coho were bigger than UW coho, and had higher survival rates, but in neither hatchery did mean annual smolt size correlate with survival

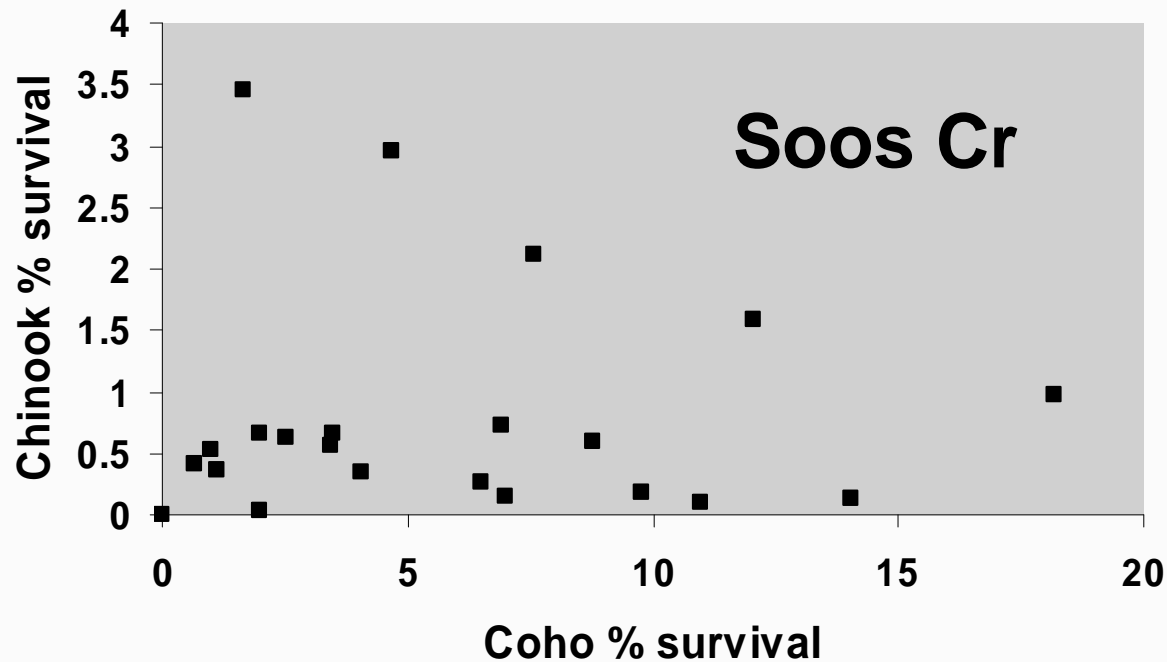


**UW chinook were bigger than Soos Creek chinook,
and had higher survival rates, but mean annual
smolt size was not correlated with survival**

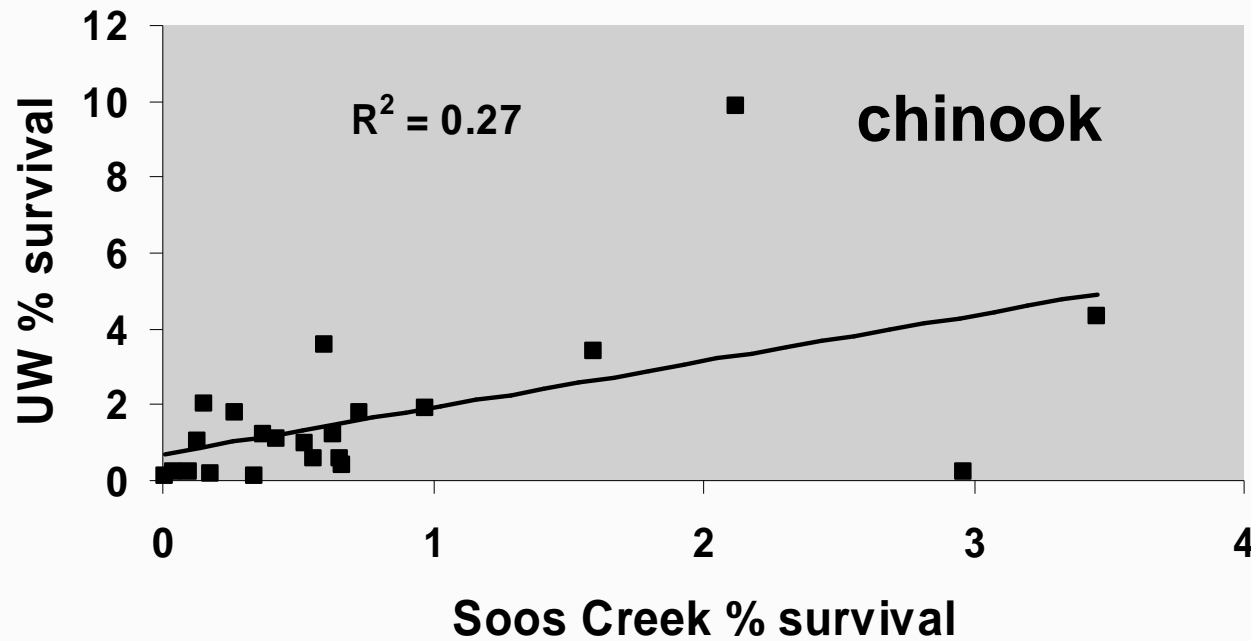




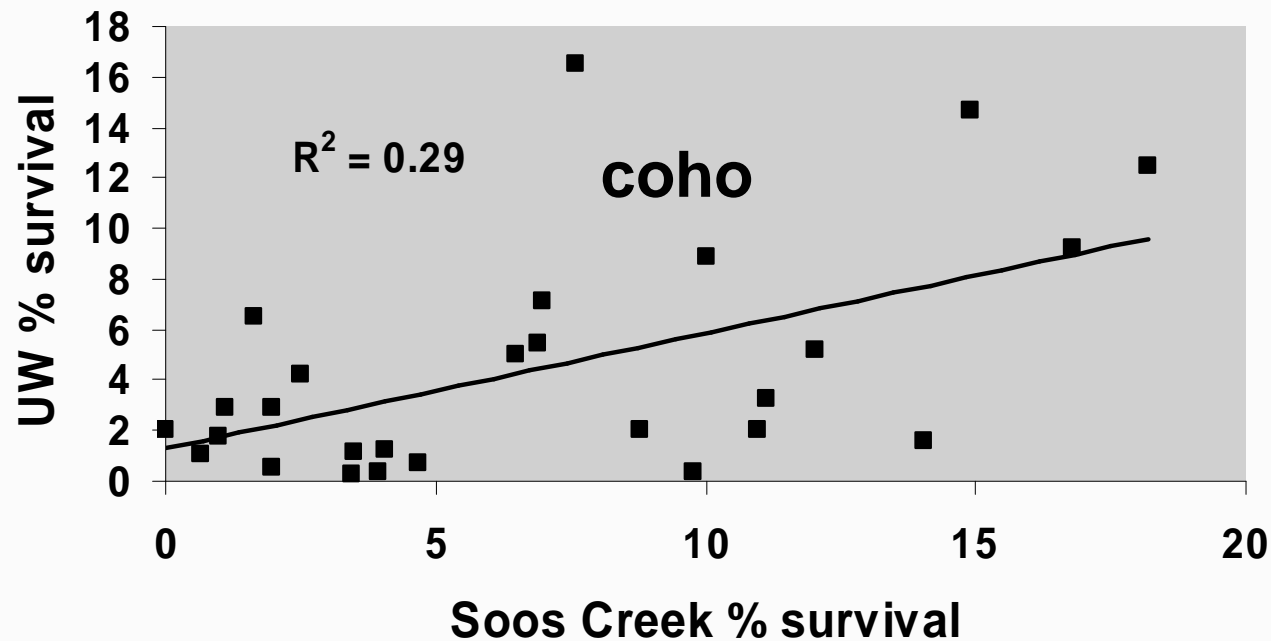
Survival rates were correlated between the two species within years at UW but not at Soos Creek hatchery.

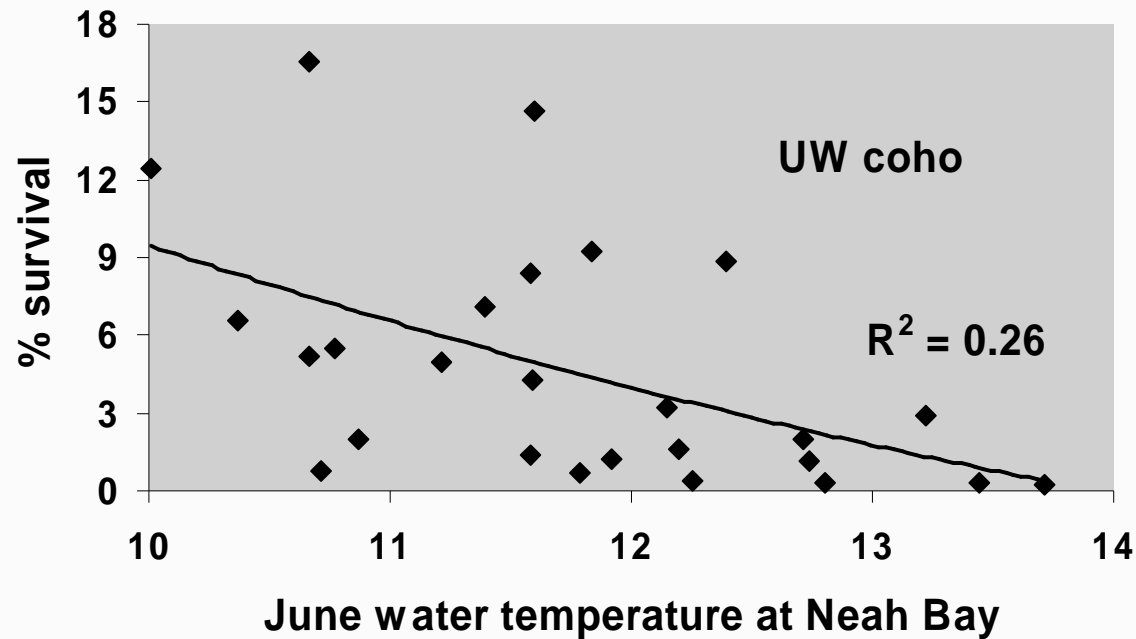


?

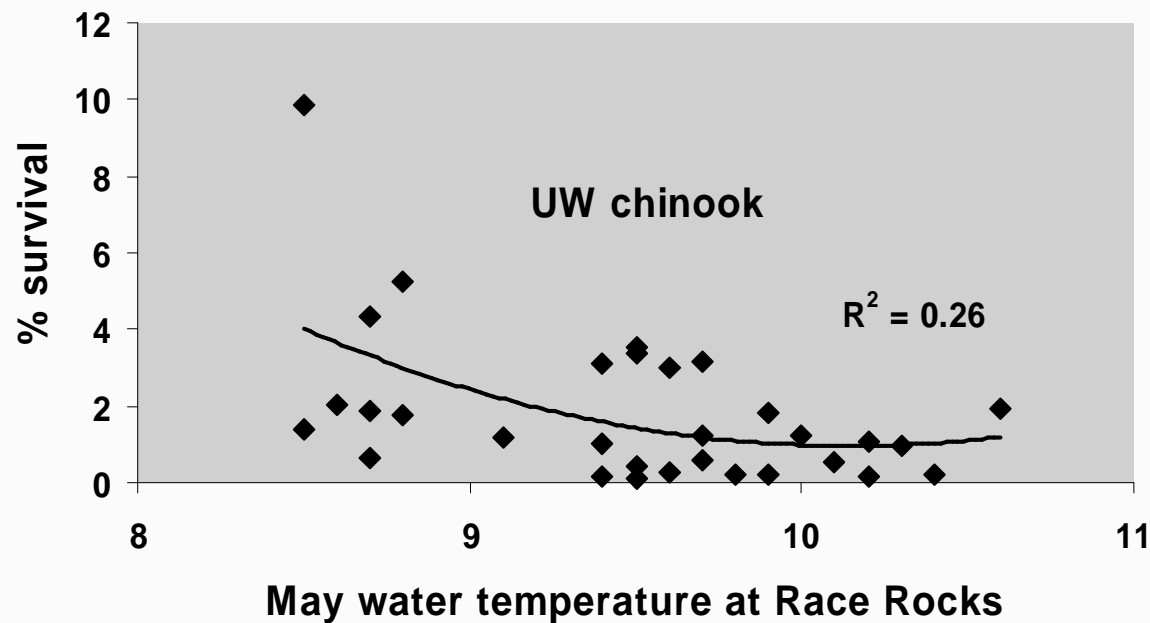


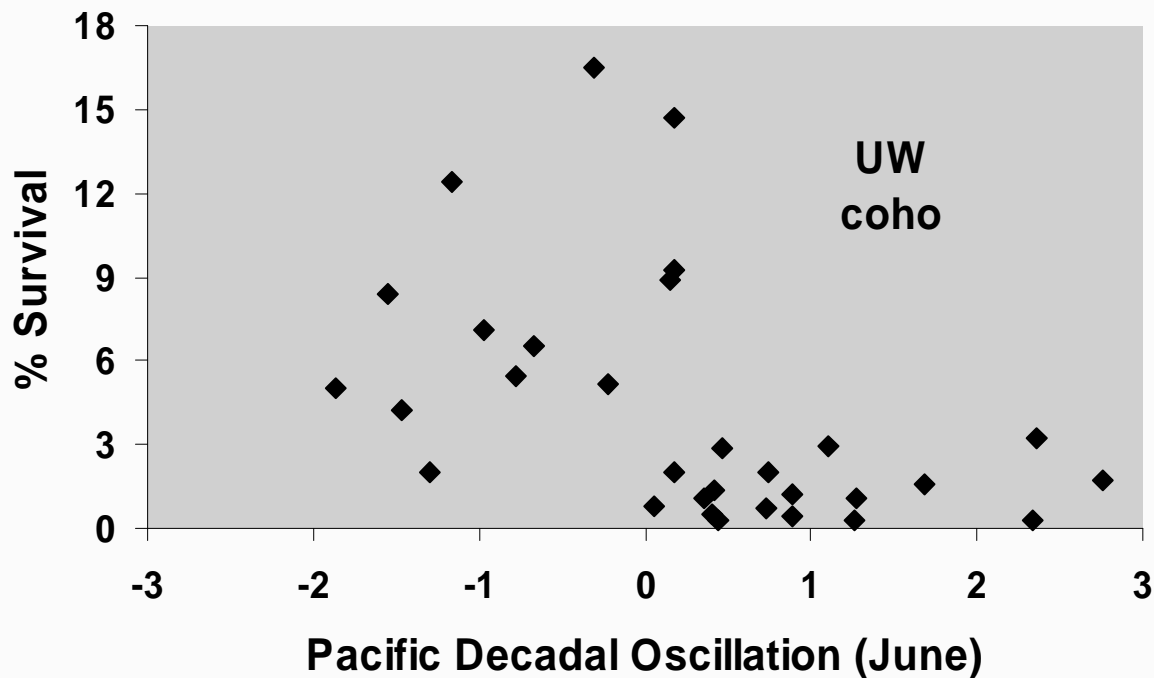
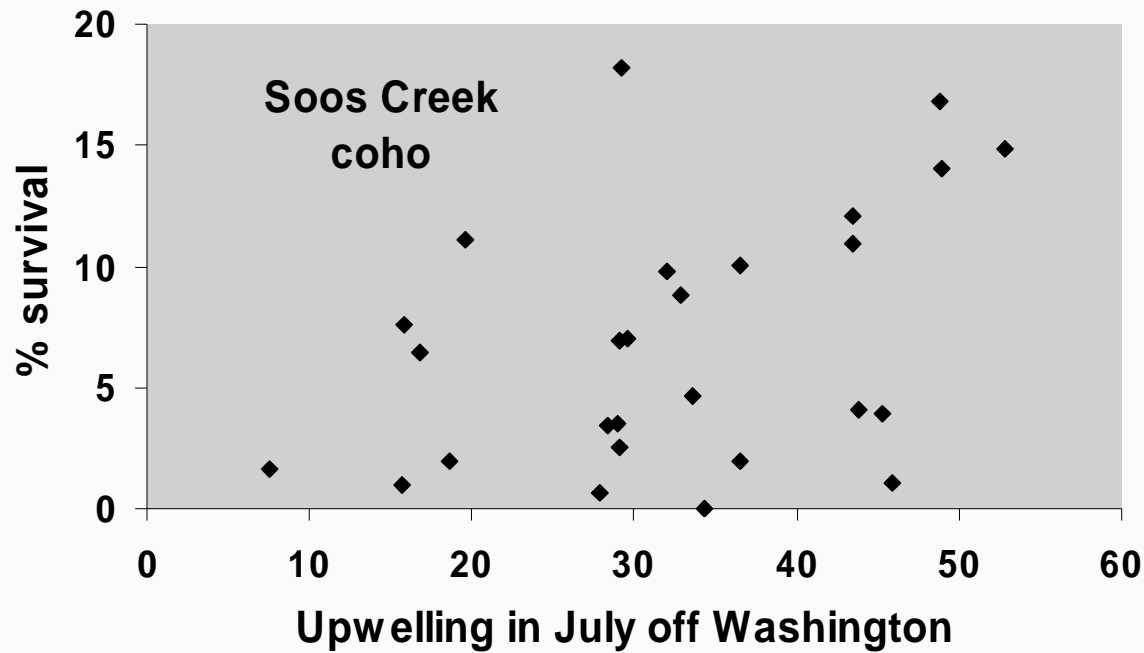
Within years, survival rates for each species between the two hatcheries were only moderately correlated.





Higher survival rates were generally associated with cooler temperatures.





Survival rates of
were also associated
with indices of ocean
conditions (e.g., PDO
and upwelling).
However, some
inconsistent or
contradictory
correlations were
also detected.

Conclusions regarding survival

Complex factors affect survival of salmon at sea. Size, release date, location, and environmental conditions all play roles but interactions among these factors (and size-selective fisheries) undermine both correlation studies and controlled experiments.

Research over wide range of scales, and with a wide range of approaches, is still much needed.

Ultimately, the actual causes of mortality are unknown, and the chronology is also uncertain.

Hearty thanks to:

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